

B: CRASHWORTHINESS (cont.)

SPECIFICATION REQUIREMENT	RTCA/DO-183 (MAY 1983)	RTCA/DO-204 (SEP 1989)	I. F. ¹	COMMENTS
6. Fire Protection	<p>Para 2.1.5 Requires that except for small parts that would not significantly contribute to propagating a fire, all materials used shall be self extinguishing.</p>	<p>Para 2.3.7 Requires that except for small parts that would not significantly contribute to propagating a fire, all materials used shall be self extinguishing, and that ELT is expected to survive post-crash fires. (a) All ELTs will be subjected to a flame test by placing the ELT directly over the center of a fire tray at a height of $1m \pm 0.025 m$ (39 ± 1 inch) for a minimum of 15 seconds. (b) AF type ELTs will be subjected to a fire test of at least $1100^{\circ} C$, producing a thermal flux of $20W/cm^2$ for a continuous and uninterrupted period of at least 2 minutes. After removal from the flame or fire test, the equipment will be allowed to cool naturally and then meet the aliveness test.</p>	+	Provides a specific requirement and establishes tests for post-crash fire survivability yielding a more reliable ELT that will operate following a post-crash fire.

¹Improvement Factor: 0 = No Improvement; + = Improvement; S+ = System Improvement; N/A = Can't be Compared

C. ELECTROMAGNETIC ENVIRONMENT REQUIREMENTS

SPECIFICATION REQUIREMENT	RTCA/DO-183 (MAY 1983)	RTCA/DO-204 (SEP 1989)	I. F. ¹	COMMENTS
1. Radio Frequency Inter-modulation	<p>Para 2.2.7a-b Reference 2.4.2.6, Figures 2-2, & 2-3; Tables 2-1 & 2-2 When the ELT unit is in the Armed mode, the application of any two frequencies in the 54-108 MHz band at +10 to +14 dBm to the ELT shall not result in reradiation of a third frequency in the 108-137 Mhz band exceeding the following levels: (a) direct coupling to the RF output terminal - the third frequency shall not exceed 83 dBm. (b) radiation coupling to external surface of the aircraft test configuration - shall not result in a third field with an intensity greater than 7 microvolts/meter at an appropriate receiving antenna 2 meters from the ELT antenna.</p>	Not Addressed	N/A	Intermodulation is not considered a factor with the 406 MHz Beacon.

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C. ELECTROMAGNETIC ENVIRONMENT REQUIREMENTS

SPECIFICATION REQUIREMENT	RTCA/DO-183 (MAY 1983)	RTCA/DO-204 (SEP 1989)	I. F. ¹	COMMENTS
2. Radio Frequency Susceptibility (not applicable to ELT (S))	Para 2.2.8 When the ELT unit is in the Armed mode, it shall not be activated or damaged when a signal in the 108-137 MHz band a +23 dBm is directly coupled to the ELT antenna terminal of for ELTs that employ externally mounted antennas, when a vertically polarized electromagnetic field of 9.6 volt/meter is applied to the external surface of the aircraft test configuration.	Para 2.2.7 & 2.3.17 Reference DO-160C, Section 20 When the ELT unit is in the Armed mode, it shall not be activated or damaged when a signal in each of the 108-121 MHz, 122-137 MHz and 420-460 MHz bands at a +23 dBm level is directly coupled to the ELT antenna terminal or for ELTs that employ integrally-mounted antennas, when a vertically polarized electromagnetic field of 200 volts/meter is applied to the external surface of the aircraft test configuration.	+	Reduces the potential for internal failures of the ELT and false activations due to external, high power transmissions. Adds additional conditional requirement of RTCA/DO-160C.
3. Normal Variation of the Electrical Power Supply Inputs	Para 2.3.12.1 Reference 2.2.6 & DO-160A, 16.5.1 and/or 16.5.2 If applicable, the ELT Remote Monitor shall operate and meet "Activation Monitor" requirements (para 2.2.6) under normal variation (surges, peaks, or ripple voltage variations, interruptions, etc.) of the aircraft electrical system, as specified in 16.5.1 and/or 16.5.2.	Para 2.3.13.1 Reference 2.2.6 & DO-160C, 16.5.1 and/or 16.5.2 Same as DO-183.	0	Reduces the potential for electrical power variations to cause inadvertent activation of remote monitor.

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C. ELECTROMAGNETIC ENVIRONMENT REQUIREMENTS (cont.)

SPECIFICATION REQUIREMENT	RTCA/DO-183 (MAY 1983)	RTCA/DO-204 (SEP 1989)	I. F. ¹	COMMENTS
4. Abnormal Conditions of the Electrical Power Supply Input	Para 2.3.12.2 Reference 2.2.6 & DO-160A, 16.5.3 and/or 16.5.4 If applicable, the ELT Remote Monitor shall withstand abnormal conditions of the aircraft electrical system, as specified in 16.5.3 and/or 16.5.4.	Para 2.3.13.2 Reference 2.2.6 & DO-160C, 16.5.3 and/or 16.5.4 Same as DO-183.	0	Same as above.
5. Voltage Spike Protection	Para 2.3.13 Reference 2.2.6 & DO-160A 17.3 (Category A) or 17.4 (Category B) If applicable, the ELT Remote Monitor shall withstand the effect of voltage spikes arriving on its power leads as specified in 17.3 or 17.4. The ELT shall not activate as a result of these tests.	Para 2.3.14 Reference 2.2.6 & DO-160C 17.3 (Category A) or 17.4 (Category B) Same as DO-183.	0	Reduces the potential for electrical power variations to cause inadvertent activation of remote monitor.

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C. ELECTROMAGNETIC ENVIRONMENT REQUIREMENTS (cont.)

SPECIFICATION REQUIREMENT	RTCA/DO-183 (MAY 1983)	RTCA/DO-204 (SEP 1989)	I. F. ¹	COMMENTS
6. Conducted Audio-Harmonics Susceptibility	<p>Para 2.3.14 Reference 2.2.6 & DO-160A, Section 18 The ELT Remote Monitor shall operate and meet "Activation Monitor" requirements when it is subjected to audio frequency components that are harmonically related to the power supply fundamental frequency as specified in Section 18. The ELT shall not activate under these conditions.</p>	<p>Para 2.3.15 Reference 2.2.6 & DO-160C, Section 18 Same as DO-183.</p>	0	Reduces probability of inadvertent activation of remote monitor due to improper equipment design.
7. Induced Audio-Signal Susceptibility	<p>Para 2.3.15 Reference 2.2.6 & DO-160A, Section 19 The ELT Remote Monitor shall operate and meet "Activation Monitor" requirements when its interconnecting wire bundle is subject to induced audio spikes and electric and magnetic fields as specified in Section 19. The ELT shall not activate under these conditions.</p>	<p>Para 2.3.16 Reference 2.2.6 & DO-160C, Section 19 Same as DO-183.</p>	0	Reduces the probability of inadvertent activation of remote monitor due to induced voltages in the wiring.

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C. ELECTROMAGNETIC ENVIRONMENT REQUIREMENTS (cont.)

SPECIFICATION REQUIREMENT	RTCA/DO-183 (MAY 1983)	RTCA/DO-204 (SEP 1989)	I. F.¹	COMMENTS
8. Radio Frequency Energy Emission	Para 2.3.16 Reference DO-160A, Section 21 The equipment shall operate within the RF conducted and radiated per- missible levels specified in Section 21.	Para 2.3.18 Reference DO-160C, Section 21 Same as DO-183.	0	Reduces the potential for the ELT to interfere with other avionics sys- tems in the aircraft and in other nearby aircraft.
9. Lightning Induced Tran- sient Susceptibility	Not Addressed	Para 2.3.19 Reference DO-160C, Section 22 The ELT shall not activate as a re- sult of lightning induced transients, and must comply with ELT con- trols, Self Test, and Aliveness re- quirements. All mechanical devices shall operate satisfactorily.	+	Increases ability of ELT to with- stand the induced effects of lighting.

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D. ENVIRONMENTAL REQUIREMENTS

SPECIFICATION REQUIREMENT	RTCA/DO-183 (MAY 1983)	RTCA/DO-204 (SEP 1989)	I. F. ¹	COMMENTS
1. Ground Survival (Non-Operating) Temperature	Para 2.3.1.1 & 2.3.1.2 Requires that ELT survive stabilized low temperature of $-55^{\circ}\text{C} \pm 3^{\circ}$ and stabilized high temperature of $+85^{\circ}\text{C} \pm 3^{\circ}$.	Para 2.3.1.1 & 2.3.1.2 Requires equipment to soak at high and low temperatures for three hours vice stabilize at those temperatures; otherwise same as DO-183.	+	Soaking units at high and low temperatures is a more stringent test than simply stabilizing the units at the temperature extremes. High temperature limit should reduce the number of internal failures.
2. Operational Temperature	Para 2.3.1.1a, 2.3.1.1b, & 2.3.1.2 Requires that ELT activate and meet operational requirements at $-20^{\circ} \pm 3^{\circ}$ with full PERP, at $-40^{\circ} \pm 3^{\circ}$ with a reduce PERP of 5 mW ($\pm 7\text{ dBm}$) during a 50 hour period, and at $+55^{\circ} \pm 3^{\circ}$ with full PERP.	Para 2.3.1.1 & 2.3.1.2 (Activation) Para 2.3.2.1 & 2.3.2.2 (Aliveness) Essentially the same as DO-183, Category C1 must activate and operate at -20 and at $+55^{\circ}\text{C}$ during the 24-hour operational life; extended Category C1 low temperature is -40°C .	0	Lower operating temperature limit in both specifications provides for equipment operation in extreme environments found in Alaska and northern states during winter months. DO-204 does not include C/S T.001 (Nov 88) requirement that operating temperature be permanently marked on beacon.
3. Operational Temperature Variation	Para 2.3.2 Reference DO-160A, Section 5 Requires that ELT must operate at maximum duty cycle during temperature variations of 2 to 5°C minimum per minute between operating temperature extremes of $+55^{\circ}\text{C}$ and -20°C .	Para 2.3.2.3 & 2.3.2.4 Reference Figure 2.7 Requires specific temperature gradient and frequency stability with thermal shock test procedures in lieu of DO-160C, Section 5. ELT must operate during temperature variations of $5^{\circ} \pm 1.0^{\circ}\text{C}$ per hour between temperature extremes, and after thermal shock of $+30^{\circ}\text{C}$ from lowest operating temperature.	0	Provides improved capability for ELT to operate following rapid temperature changes.

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D. ENVIRONMENTAL REQUIREMENTS (cont.)

SPECIFICATION REQUIREMENT	RTCA/DO-183 (MAY 1983)	RTCA/DO-204 (SEP 1989)	I. F. ¹	COMMENTS
4. Thermal Shock Endurance	Not Addressed	Para 2.3.2.4, Table 2-1 Requires a thermal shock from the minimum operating temperature (-40° C or -20° C), depending on category, to 30° C above the minimum operating temperature (i.e., either -10° C or +10° C).	+	
5. Humidity	Para 2.3.3 Reference DO-160A, 6.3.1, Category A Requires that ELT must withstand 48 hours (two cycles) of exposure in a standard humidity environment. A cycle is defined as follows: (a) 8 hours exposure to an atmosphere of 50° C and a relative humidity of at least 95%, and (b) 16 hours exposure to an atmosphere of 38° C or lower and a relative humidity of at least 85%.	Para 2.3.3 Reference DO-160C, 6.3.1, Category A Same as DO-183 with exception of added statement that ELT will not activate as a result of test.	0	

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D. ENVIRONMENTAL REQUIREMENTS (cont.)

SPECIFICATION REQUIREMENT	RTCA/DO-183 (MAY 1983)	RTCA/DO-204 (SEP 1989)	I. F. ¹	COMMENTS
6. High Altitude Survival for Installation in Non-Pressurized Compartments	Para 2.3.1.3 Reference DO-160A, Tables 4-1 & 4-2 Requires ELT equipment to withstand a low temperature of -55° C and a low-pressure equivalent to the maximum operational altitude of the aircraft on which it is installed.	Para 2.3.1.3 Provides specific test requirements in lieu of DO-160C requirements. Requires ELT equipment to withstand a low-pressure, low-temperature environment, and a compression equivalent to a drop from an altitude of 50,000 feet above mean sea level in no more than 2.5 minutes.	+	Adds a compression requirement, making test more realistic of actual conditions.
7. Decompression Survival Requirement	Para 2.3.1.4 Reference DO-160A, 4.6.2 Requires the ELT to withstand an absolute pressure reduction from 8,000 ft MSL (752.6 mbars) to the equivalent of the maximum operational altitude of the aircraft on which it is installed.	Para 2.3.1.4 Provides specific test requirements in lieu of DO-160C requirements. Requires ELT to operate at 10 psia and then withstand an absolute pressure reduction to 1 psia within 25 seconds.	0	
8. Overpressure Survival for Installations in Pressurized Compartments	Para 2.3.1.5 Reference DO-160A, 4.6.3 Requires the ELT to withstand an absolute pressure of 1697.3 mbars (15,000 feet below mean sea level).	Para 2.3.1.5 Same as DO-183.	0	

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D. ENVIRONMENTAL REQUIREMENTS (cont.)

SPECIFICATION REQUIREMENT	RTCA/DO-183 (MAY 1983)	RTCA/DO-204 (SEP 1989)	I. F. ¹	COMMENTS
9. Vibration Endurance	Para 2.3.5 In lieu of DO-160A, requires that the ELT will not activate during exposure to a vibratory motion (varying at a rate not to exceed 1.0 octave/minute) in all three major orthogonal ELT axes.	Para 2.3.5 Reference DO-160C, Section 8 Same as DO-183.	0	
10. Waterproofness	Para 2.3.7.2 (Spray Proof) Para 2.3.7.1 (Drip Proof when required) Reference DO-160A, 10.3.1 & 10.3.2 Requires that ELT in operating mode shall withstand 15 minutes of spray water on all six sides and, if required, falling drip water as specified in 10.3.1 and 10.3.2. Compliance is tested after the 15 minute water spray.	Para 2.3.8.1 (Drip Proof when required) Para 2.3.8.2 (Spray Proof) Reference DO-160C, 10.3.1 & 10.3.2 Same as DO-183.	0	Both specifications provide for improved capability to withstand water penetration.

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D. ENVIRONMENTAL REQUIREMENTS (cont.)

SPECIFICATION REQUIREMENT	RTCA/DO-183 (MAY 1983)	RTCA/DO-204 (SEP 1989)	I. F. ¹	COMMENTS
11. Salt Water Resistance (Corrosion)	Para 2.3.11 (Salt Water Spray - Optional for AF) Reference DO-160A, Section 14, Category S Requires that ELT must withstand a salt fog atmosphere at 35° C for a 48-hour period and 48-hour drying period at ambient temperatures.	Para 2.3.12 (Salt Water Spray - Optional for AF) Reference DO-160C, Section 14, Category S Same as DO-183.	0	Both specifications provide for improved capability of ELT to operate in a salt water environment.
	Para 2.3.8.2 (Salt Water Immersion - Optional for AF) Reference DO-160A, Para 11.2.2, 14.3.4, & 14.3.4.1 Requires that ELT must withstand a 24-hour salt water immersion at 30° C to 40° C and a 160-hour drying period at 65° C.	Para 2.3.9.2 (Salt Water Immersion - Optional for AF) Para 2.3.9.4 (Post Crash Immersion) Reference DO-160C, Para 11.4.2, 14.3.4, & 14.3.4.1 Salt water immersion test is same as DO-183. Post crash immersion is added requiring ELT to be activated and then survive a 1-hour immersion, submerged greater than 3 feet in salt solution 30° C to 40° C.	+	Post crash test specification provides for improved capability of ELT to operate in a salt water environment.
12. Fluids Susceptibility	Para 2.3.8.1 (Fluid Spray when required) Reference DO-160A, 11.4.1 Requires that ELT must withstand a 24-hour fine mist wetted condition and 160-hour drying period at 65° C.	Para 2.3.9.1 (Fluid Spray when required) Reference DO-160C, 11.4.1 Requires that ELT must withstand a 24-hour immersion period and 160-hour drying period at 65° C.	0	Both specifications provide improved performance of ELT installations in areas where fluid contamination could be encountered.

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D. ENVIRONMENTAL REQUIREMENTS (cont.)

SPECIFICATION REQUIREMENT	RTCA/DO-183 (MAY 1983)	RTCA/DO-204 (SEP 1989)	I. F. ¹	COMMENTS
12. Fluids Susceptibility (cont.)	Para 2.3.8.3 (Fluid Immersion when required) Reference DO-160A, 11.4.2 Requires ELT to withstand a 24-hour immersion period and a 160-hour drying period at 65° C.	Para 2.3.9.3 (Fluid Immersion when required) Reference DO-160C, 11.4.2 Same as DO-183.	0	
13. Blowing Sand and Dust Resistance	Para 2.3.9 Reference DO-160A, Section 12 When required, ELT must withstand a dust and sand jet between 0.5 and 2.5 m/sec during a 1-hour period at 25° C and 30% relative humidity along each major orthogonal axis.	Para 2.3.10 Reference DO-160C, Section 12 Same as DO-183.	0	Both specifications provide improved reliability of ELT under environmental conditions where blowing sand and dust are prevalent.
14. Fungus Resistance	Para 2.3.10 Reference DO-160A, Section 13 When required, ELT must withstand a 28-day fungus growth period at 305° C and 97% relative humidity followed by a 48-hour drying period at room temperature.	Para 2.3.11 Reference DO-160C, Section 13 Same as DO-183.	0	

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D. ENVIRONMENTAL REQUIREMENTS (cont.)

SPECIFICATION REQUIREMENT	RTCA/DO-183 (MAY 1983)	RTCA/DO-204 (SEP 1989)	I. F. ¹	COMMENTS
15. Explosion Proofness	Para 2.3.6 Reference DO-160A, Section 9 Requires that when activated in a test chamber the ELT will not cause detonation of the chamber explosive mixture (when required).	Para 2.3.6 Reference DO-160C, Section 9 Same as DO-183.	0	Both specifications provide improved reliability of ELT regarding potential to cause in-flight or post-crash explosions.

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E. INSTALLED EQUIPMENT PERFORMANCE & OPERATIONAL TESTS

SPECIFICATION REQUIREMENT	RTCA/DO-183 (MAY 1983)	RTCA/DO-204 (SEP 1989)	I. F. ¹	COMMENTS
1. Equipment Installation	Para 3.1 Provides specific requirements for ELT installation in aircraft which takes in to account accessibility, aircraft environment, display visibility, dynamic response, failure protection, inadvertent turn-off, ELT location, crash sensor orientation, antenna installation and location, and coaxial cable installation and integrity.	Para 3.3 Same as DO-183 with the exception of antenna polarity which may be either circular or vertical.	0	Both specifications provide major improvement in survivability and performance of aircraft mounted ELTs.
2. Installed Equipment	Para 3.2 Supplements paragraph 2.1 and 2.2 by adding installed equipment requirements of dynamic response and interference effects.	Para 3.2 Same as DO-183	0	
3. Condition of Test	Para 3.3 Requires testing with other avionics equipment operating.	Para 3.3 Same as DO-183	0	Both specifications provide for improved compatibility of ELT equipment with aircraft equipment.

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E. INSTALLED EQUIPMENT PERFORMANCE & OPERATIONAL TESTS(cont.)

SPECIFICATION REQUIREMENT	RTCA/DO-183 (MAY 1983)	RTCA/DO-204 (SEP 1989)	I. F. ¹	COMMENTS
4. Test Procedures for Installed Equipment Performance	Para 3.4 Requires visual and operational inspection of installed equipment to meet requirements of Section 2 with specific requirements to test Remote Monitor (audio and/or visual) and Remote Control, accessibility and interference effects.	Para 3.4 Requires visual and operational inspection of installed equipment with specific requirements to test Remote Monitor (audio and visual) and Remote Control, and equipment accessibility. Does not require tests for interference effects.	+	Both specifications add specific requirement to test both the visual and the remote monitors which will provide greater reliability of installed equipment.
5. Operational Tests	Para 4.0 Provides pre-flight and post-flight procedures, operational checks and inspection requirements.	Para 4.0 Amplifies on the procedures contained in DO-183, and requires use of self test function during pre-flight and activation monitors during post-flight.	+	Improves overall reliability by providing enhanced confidence checks of ELT on a regular basis.

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E, INSTALLED EQUIPMENT PERFORMANCE & OPERATIONAL TESTS (cont.)

SPECIFICATION REQUIREMENT	RTCA/DO-183 (MAY 1983)	RTCA/DO-204 (SEP 1989)	I. F.¹	COMMENTS
6. Power Supply	<p>Para 2.1.11 Specifies that battery shelf life shall not be greater than one-half the cell manufacturer's stated shelf life and that the expiration date be clearly marked on an external label.</p> <p>Provides for use of aircraft battery or other supplemental power supply for Remote Monitor/Control and/or charging.</p>	<p>Para 2.1.12 Reference DO-188 Requires the ELT to have its own integral battery and not depend upon any external source of power for its operation once activated. Requires provisions to ensure the watertight integrity of ELT following battery replacement. Requires that ELT not be hazardous to personnel when ELT is handled, operated, or serviced; and that ELT will not release toxic or corrosive products outside case during or subsequent to storage at temperatures between -55° C and +85° C. Defines useful life as the period after manufacture that the battery will continue to meet input power requirements subsequent to storage at +20° C. Requires that batteries be protected against polarity reversal, shorting, and the effects of self-heating, cell-to-cell charging and forced discharging.</p>	+	<p>Amplifies on requirements of DO-183 with regard to: battery useful life, shelf life, and internal battery protection. Provides for increased personal safety when handling battery. Ensures ELT watertight integrity following battery replacement.</p>

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APPENDIX B

ESTIMATED ANNUAL COST OF ELT MISSIONS

1. Data from Scott AFRCC Annual Reports

<u>YEAR</u>	<u># ELT MISSIONS</u>	<u># FLYING HOURS</u>	<u># DISTRESS MISSIONS</u>	<u>AVG. TIME RCC NOTIF. TO LOCATION</u>
1984	1410	3067	31	14.3 hrs
1985	1725	3613	39	16.13 hrs
1986	1722	3487	35	9.5 hrs
1987	1769	3121	15	9.2 hrs
1988	1863	3231	11	12.39 hrs
1989	2067	3253	3	9.4 hrs
1990	3097	3097	11	5.7 hrs
<hr/>				
AVERAGE	1800	3267	21	10.9 hrs

2. Cost formula provided by AFRCC

$$(\$482 \times A) + (\$60 \times B) = \text{cost per mission}$$

where "A" = number of hours from mission opening to closing

and "B" = total flying hours

3. Cost per year using AFRCC data

$$\text{Average mission: } (\$482 \times 10.9) + (\$60 \times 1.8) = \$5362 \text{ per mission}$$

$$\text{Times the average number of missions per year (1800); } \$5362 \times 1800 =$$

\$ 9,651,600 Annual Cost of ELT Missions

4. Cost per year using data from 484 AFRCC ELT mission folders

$$\text{Average mission: } (\$482 \times 12.9) + (\$60 \times 2.8) = \$6386 \text{ per mission}$$

$$\text{Times the average number of missions per year (1800); } \$6386 \times 1800 =$$

\$11,494,800 Annual Cost of ELT Missions

5. Assumed cost is conservative average of two data sources = \$ 10 million